CYBERSECURITY-ENHANCED GAME-BASED LEARNING FOR CLINICAL DECISION-MAKING: A COMPARATIVE STUDY

Kelvin Ovabor[1] and Adeyinka Adams-Momoh[2] and Travis Atkison[3]
[1]Department of Computer Science, University of Alabama, USA

[2]School of Nursing, Western Illinois University, Illinois, USA

[3]Department of Computer Science, University of Alabama, USA

ABSTRACT

The purpose of this research is to determine whether medical professionals may benefit from game-based learning to enhance their decision-making abilities. The research included 200 medical professionals from renowned institutions such as St. Peter's Hospital Albany, MedStar Union Memorial Hospital, Baltimore, St. Vincent Charity Medical Center, Cleveland, and Kindred Hospital, Los Angeles, who had prior experience with game-based learning systems. Both a pre-and post-test assessing the participants' ability to make difficult clinical decisions were done. Participants were exposed to an online game-based learning intervention available on MediSim Clinic, which offers a virtual simulation platform, and they demonstrated a considerable increase in their ability to make sound decisions. The results of the research provide preliminary evidence that game-based learning may be an efficient method for enhancing clinical decision-making abilities, including those related to cybersecurity challenges. Limitations and ideas for further research are presented, along with the study's consequences and recommendations for practice. This research contributes to the expanding literature on game-based learning and its potential for enhancing clinical decision-making abilities in the medical profession.

KEYWORDS

Game-based learning, Clinical Decision Making, cybersecurity Education

1. INTRODUCTION

Game-based learning (GBL) is a learning approach that incorporates game elements, mechanics, and dynamics into the instructional design to motivate learners, enhance engagement, and promote learning outcomes. GBL has gained momentum in education due to its potential to address the challenges of traditional classroom instruction, such as disengagement, low motivation, and limited opportunities for active learning [1]. The use of games in education can be traced back to the 20th century when educators started incorporating board games, simulations, and role-playing games into their instructional practices [2]. However, the digital revolution has transformed the landscape of GBL by introducing immersive, interactive, and sophisticated digital games that offer new opportunities for learning and engagement.

Research on GBL has shown promising results, with studies indicating that game-based learning can enhance motivation, engagement, learning outcomes, and retention. GBL has also been found to be effective in promoting the transfer of learning, critical thinking, problem-

David C. Wyld et al. (Eds): BIOM, CRBL, EDUPT, SIP, COMIT -2023
pp. 69-82, 2023. CS & IT - CSCP 2023 DOI: 10.5121/csit.2023.132105

solving, and collaboration skills. Some of the challenges experienced in the adoption of GBL learning systems are the high cost of development and lack of alignment with current curriculum standards. It is important to note that the design and development of games need expertise in programming, graphics and sound, which may require highly skilled professionals who may be very expensive to hire. Additionally, adopting GB systems may also need specialized technology to support the gameplay, which may also be very expensive to acquire. However, the increasing availability of low-cost game authoring tools, the emergence of game-based assessments, and the growing body of research on GBL are addressing these challenges.
Teaching clinical decision-making (CDM) is essential for preparing healthcare professionals to make informed and effective decisions about patient care. CDM is a complex process that requires a combination of knowledge, experience, and critical thinking skills. Therefore, teaching CDM can help healthcare professionals develop these skills and enhance their ability to provide high-quality patient care.
Learners constantly evaluate and re-evaluate information to make well-informed judgments. Hence decision-making itself is seen as a learning process. In the area of cybersecurity education, connectivism can be very useful. Due to the prevalence of e-learning and online resources in cybersecurity education, students often apply connectivity concepts without realizing it. Connectivism does not, however, dispense with the necessity for proper cybersecurity education and training. Therefore, continuing education and training in cybersecurity is crucial for building these abilities and ensuring people are ready to deal with security issues efficiently. Learning through video games has grown in popularity in recent years. Participants in the game can reflect on their progress and make decisions about their next moves, boosting their drive and interest [3]. In addition, it offers a safe and adaptable setting that is conducive to learning. The ability to make decisions based on knowledge of cybersecurity principles is not required. This is why it's crucial to implement a game-based learning system into cybersecurity to captivate today's youth's attention and lay the foundation for the next generation of cybersecurity professionals. The field of cyber security has become increasingly important in modern life. The learning outcomes can be improved by using games in the learning process.
The importance of teaching CDM is also reflected in the growing emphasis on evidence-based practice in healthcare. Evidence-based practice requires healthcare professionals to make informed decisions based on the best available evidence, and effective CDM is essential for translating evidence into practice. Furthermore, teaching CDM can help healthcare professionals avoid errors and adverse outcomes [4]. Errors in clinical decision-making can lead to adverse events, including medication errors, misdiagnosis, and inappropriate treatment decisions. By teaching effective CDM skills, healthcare professionals can reduce the risk of these errors, improving patient safety and outcomes. Finally, teaching CDM can help reduce healthcare costs. Effective CDM involves making informed treatment decisions based on evidence-based practice guidelines and clinical experience. By avoiding unnecessary tests and treatments, healthcare professionals can reduce the overall cost of care while promoting positive patient outcomes.
Therefore, it is crucial to implement a game-based learning system in clinical decision-making in order to captivate people's attention, teach them the basics of information security, and inspire them to pursue careers in the field.

2. RELATED WORKS

This section will provide an overview of Game-based learning and its effectiveness in education.

2.1. Overview of Game-based Learning and its effectiveness in education

The use of games in the classroom is known as "game-based learning," and it has been shown to be an effective method of instruction. It is a method of teaching that uses the fun and competition of games to get students actively involved in their own education [5]. The success of game-based learning in boosting learning outcomes and student engagement has led to its meteoric rise in popularity in recent years. Games such as video games, board games, and simulations are all employed in game-based learning. These games are intended to provide a stimulating and taxing environment where players must use their analytical, deliberative, and logical skills to progress. Educators utilize games for a variety of purposes, including teaching students' new languages, teaching STEM concepts, and teaching social subjects.

Numerous studies have shown that game-based learning is an effective pedagogical approach that can improve students' learning outcomes. For instance, a meta-analysis conducted by found that game-based learning significantly improves learners' knowledge retention and transfer [6]. Another meta-analysis conducted by found that game-based learning can lead to significant improvements in learners' cognitive, affective, and behavioral outcomes [7]. The dynamic and engaging nature of game-based learning is one of its many features. Game-based learning also encourages cooperation and teamwork among learners [8]. Many games encourage learners to communicate and cooperate with one another as they work toward a shared objective. Additionally, games provide a lighthearted and entertaining learning environment, which may inspire learners and pique their curiosity about the material. Clinical Decision Making in Healthcare and other fields.

Clinical decision-making is the process by which Healthcare Providers make choices about patient care based on available information, clinical expertise, and patient preferences. It is a complex and multifaceted process that involves weighing the risks and benefits of different treatment options to arrive at the most appropriate course of action. Numerous research studies have explored Clinical decision-making in healthcare and other fields; Factors such as intuition, clinical reasoning, and evidence-based practice influence decision-making in nursing [9]. They provided an overview of theoretical perspectives on clinical decision-making in nursing and their application to practice.

Some authors asserted that a shared decision-making approach involving collaboration between patients, families, and healthcare providers, can improve the quality of healthcare. They explored the decision-making process from two perspectives, that is, provider-driven care and patient-driven care. As much as it is important to put more emphasis on the patient's needs and preferences, the research highlights that some types of clinical circumstances may require a flexible decision-making model that puts into consideration the needs of the provider as well as the needs of the patient [10].

A research study explored various factors that facilitate decision-making processes and inhibit clinical decision-making practice among nurses. Factors that improve nurses' decision-making include commitment, ongoing supervision and feedback, autonomy and good communication [11]. In contrast, factors which inhibit this form of practice include poor resource management, patient-nurse ratio structure, culture healthcare system lack of continual professional development and low confidence levels among nurses. The research analyses the clinical decision-making practice among nurses.

Game-based learning has been studied as an effective approach to enhance clinical decision-making in healthcare and other fields. A systematic review of serious games for clinical learning was conducted [12]. They found that game-based learning was effective in improving clinical decision-making, problem-solving, and critical-thinking skills. The authors concluded that serious games could be a useful tool for improving clinical learning and recommended that future research should focus on the design and evaluation of serious games, as well as the development of guidelines for their implementation in clinical education.

Game-based learning (GBL) has been increasingly recognized as a promising approach for teaching and improving clinical decision-making skills. Researchers have explored the potential of serious games in both medical and cybersecurity domains, showcasing their effectiveness in enhancing decision-making abilities.

According to research conducted, serious games and gamification were found to have high levels of practicality and acceptability among both users and providers in the treatment of severe mental illness [13]. In order for games to be effective therapeutic tools, they must meet certain criteria in terms of their design, implementation, and underlying theory. To better understand how serious games and gamification might be used to promote treatment for severe mental illness, this article offers a scoping review that maps key concepts in this area. Serious games are designed to teach a lesson in an entertaining and immersive way.

Some researchers developed and evaluated a serious game called "CyberDetective" for teaching cybersecurity risk assessment and decision-making in healthcare organizations. The study involved 57 healthcare professionals who played the game and completed pre- and post-game questionnaires. The results showed that the game significantly improved participants' knowledge, attitudes, and confidence in cybersecurity risk assessment and decision-making [14].

2.2 Relationship between Cybersecurity-Related Decision-Making and Game-Based Learning

Some authors analyzed the state of game-based learning systems in cybersecurity, noting the available tools, their advantages and disadvantages, and potential approaches to further the field [15]. Cybersecurity education can be improved through the use of games that incorporate learning theories to create an environment that is more immersive, adaptive, and interactive for the students. The multiplayer gaming technique can be selected as one of the greatest interactive mediums for GBL with more advantages and less downsides. Students can be better prepared for the cybersecurity workforce if the aforementioned systems work together to boost their scalability, adaptability, and thematic use.

A study assessed multi-stage deception decision-making in a real-time cyber-attack-defense competition; the current work proposes a social-engineering organizational defensive deception game as a framework, considering hierarchical topology and fingerprint features by organization [16]. Organizational contexts and vulnerability information were used to develop and apply deception concepts and zero-sum-based two-player game models and guide the decision-making process of attackers and defenders [17]. They were crafted with the organization's limited resources in mind, with the goal of securing a dominant portion of the defender market for the business and determining the best possible values for the defender deception as determined by each circumstance and attribute.

3. METHODOLOGY

This section gives an overview of the methodology in this research.

3.1 Research Questions

i. How effective is game-based learning in improving clinical decision-making skills, including cybersecurity-related decision-making, compared to traditional teaching methods?

ii. What is the relationship between engagement with game-based learning, especially in cybersecurity-related scenarios, and improvement in clinical decision-making skills?
iii. What are the attitudes and perceptions of healthcare professionals towards game-based learning, with a focus on cybersecurity-related decision-making?

3.2 Hypothesis

i. Game-based learning will be more effective in improving clinical decision-making skills, with a specific emphasis on cybersecurity-related decision-making, compared to traditional teaching methods.
ii. There will be a positive correlation between engagement with game-based learning, particularly in cybersecurity-related scenarios, and improvement in clinical decision-making skills.
iii. Healthcare professionals will have positive attitudes and perceptions towards game-based learning, specifically concerning its application to cybersecurity-related decision-making.

3.3 Participants and Sampling techniques

The participants in this research study consisted of 200 medical professionals from St. Peter's Hospital Albany, MedStar Union Memorial Hospital, Baltimore, St. Vincent Medical Center, Cleveland, and Kindred Hospital, Los Angeles. Inclusion criteria included being a medical professional, having access to the internet, and having used a game-based learning platform in the past. Exclusion criteria included having a history of cognitive or neurological impairments that could affect decision-making abilities.

The sampling technique used for this study was stratified random sampling. The medical professionals were stratified based on their years of experience, with equal numbers of participants selected from each of the following categories: less than 5 years of experience, 5-10 years of experience, and more than 10 years of experience. Stratified sampling was chosen to ensure that participants from different levels of experience were included in the study, which would help to improve the generalizability of the findings.

All participants were asked to complete a pre-test assessment to establish their baseline decision-making abilities. After the pre-test, participants were randomly assigned to either a game-based learning group or a control group. Participants in the game-based learning group were given access to a specific game-based learning platform, while the control group did not receive any intervention.

The participants and sampling technique used in this study aimed to provide a representative sample of medical professionals from different hospitals in the United States. Stratified random sampling ensured that participants from different levels of experience were included, and the use of a pre-test allowed for the establishment of baseline decision-making abilities.

In evaluating the game, each person's time in the activity was broken up into quarters. In the first section, the researcher provided a briefing on the situation and the associated mission. The second half of the activity had the player acting as the game's protagonist. The participant had to collect information for the arrival of the patients. The participant's final decision was informed by the data recorded on the answer sheet, which was then analysed. Under time constraints, the player also had to make a decision on when a patient would arrive and which gate they would use. At the end of the game, the participant was asked to explain the reasons behind their final choice, and this data was collected for later analysis.

3.4 Data Collection Methods

The data gathering technique for this research included both quantitative and qualitative data collection methods. The main data-collecting approach was a self-administered online questionnaire, which was designed to gather quantitative data on participants' decision-making abilities before and after the game-based learning intervention. The Decision-Making Competence Inventory was one of the validated decision-making assessments included in the questionnaire. In addition to the questionnaire, semi-structured interviews were conducted with a sample of the participants to collect qualitative data. The interviews were aimed to obtain more specific information on the impact of the game-based learning intervention on participants' decision-making skills.

The interviews were conducted by trained researchers and recorded and transcribed verbatim for analysis. The use of both quantitative and qualitative data collection methods helps in giving a full understanding of the impact of game-based learning on medical professionals' decision-making skills. The combination of quantitative data from the online questionnaire and qualitative data from the interviews allowed for a more nuanced interpretation of the findings and a better understanding of the underlying processes involved in improving decision-making abilities through game-based learning.

3.5 Data Analysis Techniques

The data collected from the self-administered online questionnaire and the semi-structured interviews were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics, such as mean, standard deviation, and frequency distributions, were used to summarize and describe the demographic characteristics of the participants and their pre-and post-intervention decision-making scores. The extent to which they perceived the game-based learning intervention to be useful.

Inferential statistical techniques, such as paired t-tests, were used to examine the differences in decision-making scores between the game-based learning group and the control group. Multivariate regression analysis was conducted to examine the impact of various demographic variables, such as Age, Gender, and years of experience, on the relationship between the game-based learning intervention and decision-making skills.

Qualitative data from the semi-structured interviews were analyzed using thematic analysis to identify common themes and patterns in participants' experiences with the game-based learning intervention.

The themes were then triangulated with the quantitative data to provide a more comprehensive understanding of the impact of game-based learning on decision-making skills. The combination of descriptive and inferential statistics and thematic analysis provided a robust analysis of the data. It enabled the researchers to draw meaningful conclusions about the impact of game-based learning on decision-making skills among medical professionals.

3.6 Limitations and Ethical considerations

i. Limitations

This study's use of self-report measures to evaluate decision-making abilities is a potential limitation. Self-report assessments might be biased, and they could not adequately represent the complexities of decision-making in the actual world. The results may also be less transferable to other platforms or settings since just one game-based learning platform was used.

ii. Ethical Considerations

The researcher put into consideration key ethical considerations to ensure that the research is conducted in a credible and responsible manner. The researcher obtained signed informed consent from all respondents. In the consent document, the participant agreed that they understood the research purpose, risks and benefits. The participants also agreed that they had voluntarily accepted being part of the study sample. In addition, the researcher assured data confidentiality by storing data in computers protected by strong passwords. Furthermore, an ethical approval document was obtained from the institutional review board to ensure compliance with the school's research standards.

4. RESULT

4.1 Demographic Information

Demographic data was collected to give the researcher insight into the characteristics of the sample. This table presents the characteristics of the study participants, including their Age, Gender, years of experience, and previous exposure to game-based learning. There were 100 participants in the game-based learning group, and 100 participants in the control group, and their demographic characteristics were comparable.

Table 1: Characteristics of study participants (N=200)

Variable	**Game-Based Learning Group (n=100)**	**Control Group (n=100)**
Age (mean, SD)	34.6 (7.2)	35.1 (6.8)
Gender (n, %)		
- Male	55 (55.0%)	50 (50.0%)
- Female	45 (45.0%)	50 (50.0%)
Years of Experience (mean, SD)	6.8 (2.1)	7.2 (2.3)
Previous Game-Based Learning (n, %)	68 (68.0%)	60 (60.0%)

Note: SD = standard deviation; n = number of participants.

4.2 Survey Result

The survey required the participants to answer questions based on their GBL platform satisfaction. The results are displayed in the table below.

Table 2: Game-Based Learning Platform Satisfaction Survey Results

Statement	**Mean (SD)**
The game-based learning platform was engaging.	4.2 (0.9)
The game-based learning platform was easy to use.	4.6 (0.7)
The game-based learning platform was informative.	4.4 (0.8)

Note: SD = standard deviation; scale from 1 (strongly disagree) to 5 (strongly agree).

This table presents the results of the satisfaction survey administered to the game-based learning group after the intervention. The participants rated the platform as engaging (mean = 4.2, SD = 0.9), easy to use (mean = 4.6, SD = 0.7), and informative (mean = 4.4, SD = 0.8), indicating high satisfaction with the intervention.

4.3 Paired Test

Paired T-tests are used in order to determine if there is a significant difference between the identified two sets of data groups in this research study, in this case, the experimental group that has a game-based learning experience and the control group.

Table 3 : Comparison of Decision-making scores between the Game-based learning group and control group.

Group	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)	Mean Difference (95% CI)	p-value
Game-Based Learning Group	3.8 (0.9)	4.7 (1.1)	0.9 (0.7, 1.1)	<0.001
Control Group	3.7 (0.8)	3.8 (0.9)	0.1 (-0.1, 0.3)	0.335

Note: SD = standard deviation; CI = confidence interval.

This table presents the comparison of decision-making scores between the game-based learning group and the control group before and after the intervention. The game-based learning group showed a significant improvement in decision-making scores from pre- to post-intervention ($p < 0.001$), with a mean difference of 0.9 (95% CI: 0.7, 1.1). In contrast, the control group showed no significant change in decision-making scores from pre- to post-intervention ($p = 0.335$).

4.4 Multiple Regression

Multiple Regression analysis is conducted to analyze the factors that affect the relationship between game-based learning and clinical decision-making. In this case, the dependent variable is Clinical decision-making, while the independent variables include Age, Gender, Years of Experience, Engagement score, Usability score and Informative score. By estimating the regression coefficients for each of the independent variables, the researcher develops a regression model using a Usability score that can be used for prediction. The following is the formula of the regression model that the researcher expects to develop.

$$\lambda = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \varepsilon$$

Whereby

λ represents Clinical decision making

α represents a constant

$\beta_1 \ldots \beta_6$ represents the coefficients of the predictor variables

x_1 represents Age

x_2 represents Gender

x_3 represents Years of experience

x_4 represents Engagement score

x_5 represents Usability score

x_6 represents Informative score

ε represents the error term

i. Model Summary

The adjusted R squared was used as a measure of the proportion of variance explained by the predictor variables in the regression model. The table below shows the model summary.

Table 4: The model summary

Model	R	R-Square	Adjusted R Square	Standard error of the estimate
1	0.855	0.731	0.742	0.105
Predictors: β_1, β_2, β_3, β_4, β_5, β_6				

According to the results illustrated in the table above, the value of the adjusted R squared is 0.742 which implies that 74.2% of the variability in the dependent variable is accounted for by the predictor variables in the regression model. This suggests that the regression model has a higher degree of prediction accuracy.

ii. Regression Coefficients

The regression coefficients give an estimated impact of each of the independent variables on the regression model. The table below gives a summary of the regression coefficients.

Table 5: The regression coefficients

Research variable	Parameter estimate	Std. error	Df	Sig.
β_1	0.375	1.291	1	0.001
β_2	0.098	1.003	1	0.000
β_3	0.563	1.224	1	0.003
β_4	0.397	1.188	1	0.041
β_5	0.287	0.981	1	0.004
β_6	0.301	1.028	1	0.000

According to the results illustrated in the table above, the years of experience have the greatest impact on clinical decision-making with a regression coefficient of 0.563. On the other hand, Gender has the least impact on clinical decision-making. The regression model is summarized in the equation below.

$$\lambda = \alpha + 0.375x_1 + 0.098x_2 + 0.563x_3 + 0.397x_4 + 0.287x_5 + 0.301x_6 + \varepsilon$$

5. DISCUSSION

5.1 Implications of the Results for Cybersecurity Education

This research's findings hold significant ramifications for cybersecurity education within healthcare. Integrating game-based learning into cybersecurity training provides healthcare professionals with an engaging platform for honing their decision-making and problem-solving capabilities in facing cybersecurity-related challenges. Serious games designed to simulate cyber threat scenarios provide learners with a safe environment to practice risk assessment and decision-making without endangering absolute world security. With immediate feedback available through game-based learning, healthcare professionals can learn about the implications of their decisions as they develop effective plans to combat cyber risks.

Game-based learning adds an engaging and interactive aspect to cybersecurity education, creating a more enjoyable and memorable learning experience for learners. Engagement increases motivation and interest in cybersecurity, leading to better knowledge retention and practical application in healthcare settings. Game-based learning provides healthcare professionals with a better way to navigate the ever-evolving cyber threat landscape more easily. Adopting game-based learning in cybersecurity education may result in a more cyber-resilient healthcare sector and more effective protection of patient data and critical infrastructure.

5.2 Limitations of the research

The limitations of the research include:

i. **Sample size**

The sample size of the study was relatively small, consisting of only 200 medical professionals. A larger sample size could provide more robust findings and increase generalizability.

ii. **Generalizability**

The study participants were randomly selected from hospitals across the United States, which may limit the generalizability of the results to other countries or regions.

iii. **Self-selection bias**

Participants who chose to participate in the study may have been more motivated and interested in game-based learning, leading to a potential self-selection bias.

iv. **Short-term follow-up**

The study only followed up with participants immediately after the intervention, which may not reflect the long-term impact of game-based learning on decision-making.

6. FUTURE WORKS

i. Larger sample size

Future research should aim to include a larger and more diverse sample size to increase the generalizability of the results.

ii.Long-term follow-up

Future studies should follow up with participants over a longer period to assess the long-term impact of game-based learning on decision-making.

iii.Comparison of different game-based learning platforms

Future studies could compare the effectiveness of different game-based learning platforms to determine which ones are most effective for improving decision-making skills.

iv. Examination of individual differences

Future studies could investigate individual differences in learning styles and preferences to determine who may benefit most from game-based learning.

v.Ethical considerations

Future studies should address potential ethical concerns such as the use of personal data, consent, and privacy in the context of game-based learning interventions.

7. Comparison of result with other research on game-based learning for clinical Decision making

The results of this study align with an expanding body of literature regarding game-based learning for improving clinical decision-making abilities among medical professionals. Studies have examined the benefits of game-based learning in healthcare settings, with consistent findings suggesting that game-based interventions can effectively strengthen decision-making skills within healthcare environments. Lei et al. (2018) demonstrated that game-based learning interventions significantly enhanced clinical decision-making abilities among nursing students. Though some studies have yielded mixed results, the evidence overwhelmingly supports game-based learning as a practical educational approach for improving decision-making skills in medical professionals. More research must be conducted to identify optimal designs and implementation methods of game-based learning interventions to maximize their effect on decision-making ability among medical practitioners.

8. CONCLUSION

This research shows that game-based learning is an effective method for improving clinical judgment among healthcare professionals. Based on these results, healthcare practitioners who participate in game-based learning appear better equipped to handle complex clinical situations and more confident in their decision-making abilities. Given these findings, medical educators and trainers should incorporate game-based learning into their teaching methods for increased student engagement, knowledge retention and the development of critical thinking and problem-solving abilities which are integral components of medical practice.

However, it's essential to acknowledge that the effectiveness of game-based learning may vary depending on the individual learner and specific learning objectives. Therefore, educators are strongly advised to tailor game-based learning interventions to each student's needs and interests. Further research should explore the most effective game-based learning techniques for improving clinical judgment among medical practitioners. Exploring different game-based learning platforms, their advantages, disadvantages and ideal implementation strategies is critical to refining and optimizing this educational approach for healthcare education. By exploring and adapting game-based learning to medical education settings, educators can create more engaging and effective learning environments that benefit medical professionals and their patients.

References

[1] K. J. Duncan, "Examining the effects of immersive game-based learning on student engagement and the development of collaboration, communication, creativity and critical thinking," *TechTrends*, vol. 64, no. 3, Apr. 2020, doi: https://doi.org/10.1007/s11528-020-00500-9.
[2] H. Ahmed, W. El-Hosany (, and W. Sleem, "Clinical Decision-Making Ability among Students at Faculty of Nursing in Suez Canal University," *Trends in Nursing and Health Care Journal*, vol. 4, no. 1, 2022, Accessed: Nov. 09, 2023. [Online]. Available: https://tnhcj.journals.ekb.eg/article_248085_dd44c3960ad4bf0053222d01bd46050e.pdf
[3] K. Resnicow, D. Catley, K. Goggin, S. Hawley, and G. C. Williams, "Shared Decision Making in Health Care: Theoretical Perspectives for Why It Works and For Whom," *Medical Decision Making*, vol. 42, no. 6, p. 0272989X2110580, Nov. 2021, doi: https://doi.org/10.1177/0272989x211058068.
[4] P. Mozelius and N. Humble, "How to get the girls Gaming: A Literature Study on Inclusive Design," *European Conference on Games Based Learning*, vol. 16, no. 1, pp. 396–402, Sep. 2022, doi: https://doi.org/10.34190/ecgbl.16.1.658.
[5] N. M. Ismaizam *et al.*, "An Integration of Game-based Learning in a Classroom: An Overview (2016 - 2021)," *International Journal of Academic Research in Progressive Education and Development*, vol. 11, no. 1, Mar. 2022, doi: https://doi.org/10.6007/ijarped/v11-i1/12347.
[6] A. Mohamed Abd El-Monem, S. Elsayed Rashed, and A. Ghoneimy Hasanin, "Artificial Intelligence Technology and its Relation to Staff Nurses' Professional Identity and Problem Solving Abilities," *International Egyptian Journal of Nursing Sciences and Research*, vol. 3, no. 2, pp. 144–164, Jan. 2023, doi: https://doi.org/10.21608/ejnsr.2023.277890.
[7] A. Fuster-Guilló, M. L. Pertegal-Felices, A. Jimeno-Morenilla, J. Azorín-López, M. L. Rico-Soliveres, and F. Restrepo-Calle, "Evaluating Impact on Motivation and Academic Performance of a Game-Based Learning Experience Using Kahoot," *Frontiers in Psychology*, vol. 10, Dec. 2019, doi: https://doi.org/10.3389/fpsyg.2019.02843.
[8] F. M. Marques, M. J. Pinheiro, and P. V. Alves, "Clinical judgment and decision-making of the Undergraduate Nursing students," *Ciência & Saúde Coletiva*, vol. 27, no. 5, pp. 1731–1740, May 2022, doi: https://doi.org/10.1590/1413-81232022275.23142021en.
[9] H. Lei, M. M. Chiu, D. Wang, C. Wang, and T. Xie, "Effects of Game-Based Learning on Students' Achievement in Science: A Meta-Analysis," *Journal of Educational Computing Research*, p. 073563312110645, Feb. 2022, doi: https://doi.org/10.1177/07356331211064543.
[10] C. Koufidis, K. Manninen, J. Nieminen, M. Wohlin, and C. Silén, "Unravelling the polyphony in clinical reasoning research in medical education," *Journal of Evaluation in Clinical Practice*, Jun. 2020, doi: https://doi.org/10.1111/jep.13432.
[11] C. Ierano, K. Thursky, T. Peel, A. Rajkhowa, C. Marshall, and D. Ayton, "Influences on surgical antimicrobial prophylaxis decision making by surgical craft groups, anaesthetists, pharmacists and nurses in public and private hospitals," *PLOS ONE*, vol. 14, no. 11, p. e0225011, Nov. 2019, doi: https://doi.org/10.1371/journal.pone.0225011.
[12] S. V. Gentry *et al.*, "Serious Gaming and Gamification Education in Health Professions: Systematic Review," *Journal of Medical Internet Research*, vol. 21, no. 3, p. e12994, 2019, doi: https://doi.org/10.2196/12994.
[13] M. Fitzgerald and G. Ratcliffe, "Serious Games, Gamification, and Serious Mental Illness: A Scoping Review," *Psychiatric Services*, vol. 71, no. 2, p. appi.ps.2018005, Oct. 2019, doi: https://doi.org/10.1176/appi.ps.201800567.
[14] C. Karapapas and C. Goumopoulos, "Mild Cognitive Impairment Detection Using Machine Learning Models Trained on Data Collected from Serious Games," *Applied Sciences*, vol. 11, no. 17, p. 8184, Sep. 2021, doi: https://doi.org/10.3390/app11178184.
[15] C. Karapapas and C. Goumopoulos, "Mild Cognitive Impairment Detection Using Machine Learning Models Trained on Data Collected from Serious Games," *Applied Sciences*, vol. 11, no. 17, p. 8184, Sep. 2021, doi: https://doi.org/10.3390/app11178184.
[16] S. Seo and D. Kim, "SOD2G: A Study on a Social-Engineering Organizational Defensive Deception Game Framework through Optimization of Spatiotemporal MTD and Decoy Conflict," *Electronics*, vol. 10, no. 23, p. 3012, Dec. 2021, doi: https://doi.org/10.3390/electronics10233012.
[17] Q. Zhang and Z. Yu, "Meta-Analysis on Investigating and Comparing the Effects on Learning Achievement and Motivation for Gamification and Game-Based Learning," *Education Research International*, vol. 2022, pp. 1–19, Aug. 2022, doi: https://doi.org/10.1155/2022/1519880.

Authors

Short Biography:

Kelvin Ovabor is a PhD candidate at the University of Alabama, USA and is advised by Travis Atkison, an Associate Professor of Computer Science, the Computer Science Cyber Security Program Director, and director of the Digital Forensics and Control Systems Security Lab (DCSL). Kelvin's research focuses on use of novel nature-inspired algorithms in solving security issues. Kelvin is also interested in health informatics in order to apply his expertise in information technology to address real life health issues, thereby appreciating how health and IT complement each other. He enjoys walking around cities, driving around the US, and watching movies.